

# Silicone Substitution

## ROI: The Financial Penalty of Delayed Reformulation in 2026

### KEY FIGURES

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#### 6 June 2026

REACH D4/D5/D6 restriction  
effective — general consumer use

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#### +10% / +25%

Silicone price increases 2024  
Shin-Etsu; specialist additives

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#### 90%

EU target emissions reduction  
from D4/D5/D6 restriction

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#### \$46.93B

TPE alternatives market by 2033  
\$29.71B in 2024, CAGR 5.21%

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D4 · D5 · D6 Restriction · REACH Compliance · Material Cost Analysis

TPE · TPV · Polyurethane · Silicone Alternatives ROI Framework

# 1 Executive Summary

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The silicone industry faces a structural inflection in 2026. Commission Regulation (EU) 2024/1328 — adopted 16 May 2024 — brings the restriction of cyclic siloxanes D4, D5 and D6 into force for general consumer and professional use on June 6, 2026. For manufacturers, formulators and downstream users of silicone-based products who have not yet initiated reformulation, this date is not an abstraction. It is a hard market access cutoff carrying financial consequences that compound the longer action is deferred.

This paper maps four distinct cost vectors activated by delayed reformulation: raw material price volatility, direct regulatory compliance costs, market access loss, and long-term liability accumulation. It then quantifies the ROI case for proactive substitution — using thermoplastic elastomers (TPE), thermoplastic vulcanizates (TPV), polyurethane systems, MS polymers, and EPDM — across four principal application sectors: personal care, construction/industrial sealants, automotive, and coatings.

**June 6, 2026**

REACH D4/D5/D6 restriction  
(general use, EU)

**+10% / +25%**

Silicone price increases  
Shin-Etsu Jul 2024 / specialist  
additives

**3%**

Tested cosmetics found  
non-compliant (ECHA pilot  
2022)

**\$46.93B**

TPE market by 2033 from  
\$29.71B in 2024, CAGR  
5.21%

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## The Core Argument

The 'wait and see' position on silicone reformulation is no longer a defensible commercial strategy in 2026. The penalty for inaction is not theoretical — it is a combination of rising input costs, direct compliance obligations that are already in force, market access restrictions that activate on a specific date, and reputational exposure from continued use of substances the EU has classified as very persistent, very bioaccumulative, and — in the case of D4 — highly toxic to aquatic life. Each quarter of delay adds cost. It does not preserve optionality.

## 2 The Silicone Market in 2026 — Size and Structural Pressure

The global silicone market was valued at between \$22.67B and \$24.26B in 2024, depending on scope definition and source methodology, growing at a consensus CAGR of 5.4–6.15% (Grand View Research, Polaris Market Research). Asia-Pacific dominated with 45.79% of global revenue in 2025, driven by China's construction, electronics, and automotive sectors. Europe is the second-largest market, with particular exposure to the regulatory pressure wave now arriving in 2026.

Source	2024 Valuation	CAGR	Forecast	Key Drivers / Notes
Grand View Research (2025)	\$24.26B	5.4%	\$37.31B by 2033	Elastomers largest segment; personal care fastest-growing
Polaris Market Research	\$22.67B	6.15%	Not stated	Asia-Pacific led; elastomers and fluids dominant by revenue
IMARC Group	\$15.2B	4.8%	\$23.1B by 2033	Narrower scope (excludes semiconductor/PV-grade silicon)
Maximise Market Research	\$22.88B	6.1%	\$36.54B by 2032	Construction and automotive primary drivers

Note: Market valuation differences reflect scope (silicone vs. silicon, including/excluding semiconductor-grade material, regional coverage). Directional agreement on 5–6% CAGR is strong.

### 2.1 Where the Pressure Is Concentrated

The regulatory and market pressure in 2026 is not distributed evenly across the silicone value chain. Industrial production of silicone polymer — the manufacturing step where D4, D5 and D6 are used as monomers — is explicitly derogated from the restriction. The pressure falls on downstream formulation and application: personal care formulators, cosmetics manufacturers, construction sealant producers, automotive part manufacturers using cVMS-based coatings, and dry cleaning operators using D5 as a solvent.

Application Category	Restriction Date	Threshold	Products / Sectors Affected
Consumer/professional products (general use)	June 6, 2026	≥0.1% w/w D4/D5/D6	Personal care, waxes, polishes, cleaning products, industrial lubricants
Cosmetics — leave-on products	June 6, 2027	≥0.1% w/w D5/D6	Make-up, face creams, hair styling products
Medical devices / veterinary products	June 6, 2031	Application-specific	Medical device implants, veterinary treatments
Dry cleaning — D5 as solvent	June 6, 2034	D5 in open systems	Textile cleaning; closed-loop recycling systems derogated
Silicone polymer production (D4/D5/D6 as monomer)	Not restricted	N/A — derogated	Upstream production of silicone polymer unaffected

Source: Commission Regulation (EU) 2024/1328 of May 16, 2024; ECHA Cyclosiloxanes page (2025); H2 Compliance (2025).

### 3 D4, D5 and D6 — Classification, Properties and Regulatory History

Cyclic volatile methyl siloxanes D4 (octamethylcyclotetrasiloxane), D5 (decamethylcyclopentasiloxane) and D6 (dodecamethylcyclohexasiloxane) are silicone-based ring compounds — the foundational intermediates in the production of silicone polymers such as oils, rubbers and resins. Their functional properties — smoothness, film-forming, thermal stability, hydrophobicity — made them ubiquitous in personal care formulation and industrial application for several decades.

The EU's concern centres on their environmental persistence. D4, D5 and D6 are classified as Substances of Very High Concern (SVHC) under REACH for being very persistent and very bioaccumulative (vPvB). D4 carries additional classification as persistent, bioaccumulative and toxic (PBT), highly toxic to aquatic life with long-lasting effects, and suspected of damaging fertility. All three have been detected in sewage sludge, soil, water, and in organisms in remote regions including the Arctic, confirming long-range environmental transport potential.

Substance	EC Number	Classification / Hazard	Regulatory Status
D4 — Octamethylcyclotetrasiloxane	EC 209-136-7	vPvB + PBT + reproductive toxicity suspect + highly toxic aquatic life (long-lasting)	Banned in cosmetics Jan 2022 Full REACH restriction June 2026
D5 — Decamethylcyclopentasiloxane	EC 208-764-9	vPvB when $\geq 0.1\%$ D4 present Bioaccumulative, environmentally persistent	Rinse-off cosmetics restricted Jan 2020 Leave-on and general use: June 2026/2027
D6 — Dodecamethylcyclohexasiloxane	EC 208-762-8	vPvB when $\geq 0.1\%$ D4 or D5 present Long-range transport potential confirmed	Full REACH restriction June 2026 Leave-on cosmetics: June 2027

Sources: ECHA Candidate List (June 2018 inclusion); Commission Regulation (EU) 2024/1328; ECHA Cyclosiloxanes topic page.

#### ECHA Enforcement Evidence — Not a Future Risk

In 2022, ECHA's Enforcement Forum conducted a pilot market survey checking cosmetic products for compliance with existing D4/D5 restrictions. 3% of tested products were found non-compliant. Non-compliant products were withdrawn from the market. This occurred under the existing restricted-substance framework — before the broader 2024 restriction entered force. The 2026 restriction covers a substantially wider product and substance scope. The enforcement infrastructure is operational. The 3% non-compliance rate from 2022 is the floor, not the ceiling, for what enforcement action will find in 2026–2027.

## 4 The Four Financial Penalties of Delayed Reformulation

Delayed reformulation is often framed as a risk management issue — something to be monitored and addressed in due course. The financial structure of the 2026 regulatory moment makes this framing incorrect. The penalties are not potential. They are accumulating now across four separate cost vectors, each of which is already active.

### 4.1 Penalty One: Raw Material Cost Volatility

Silicone raw material prices have been under significant upward pressure since 2023. In June 2024, Shin-Etsu Chemical announced a global price revision of 10% or more across all silicone products, effective July 1, 2024, citing rising raw material costs and energy prices. For specialist silicone additives used in personal care, coatings and sealants, adjustments of up to 25% have been documented in trade channels, driven by a combination of commodity cost transmission, energy-intensive production costs in Asia, and supply chain instability from logistics disruptions.

The structural driver compounds the cyclical one: as D4/D5/D6-compliant reformulations become mandatory across the EU market, demand for compliant alternative chemistries — and for the sub-threshold silicone grades that remain permitted — will increase, applying further pressure to already constrained supply. Manufacturers who have not reformulated by mid-2026 will be purchasing into a tightening compliant-material market while simultaneously facing non-compliance risk on existing product lines.

Material	Approx. Price Range	2024–2026 Price Movement	Context
Standard silicone fluids (compliant sub-threshold)	~\$3.50–5.00/kg	+8–12% vs 2022 baseline	Supply constrained as compliant alternatives displace D4/D5/D6 grades
Specialist cVMS-compliant personal care emollients	~\$8–18/kg	Up to +25% on specialist grades	Limited supplier base; Sonneborn, Evonik, BASF alternatives cited
Cyclopentasiloxane D5 (restricted June 2026)	~\$4–6/kg	Declining — exit pricing	Cannot be placed on EU market $\geq 0.1\%$ w/w after 6 June 2026
TPE/TPV alternatives (non-silicone)	~\$2.50–6.00/kg	Stable to +5% (2024–2026)	Growing market (\$29.71B); multiple suppliers; lower energy intensity
MS polymers / hybrid sealants	~\$3.00–7.00/kg	Flat to +3%	Increasing adoption in construction sealants as silicone substitutes

Sources: Shin-Etsu press release June 2024; Allied Market Research; IMP trade channel analysis; Mordor Intelligence TPE data 2026. If heat resistance  $>200\text{C}$  is required, move to compliant/recycled silicone; if  $<140\text{C}$ , consider TPV/TPE.

### 4.2 Penalty Two: REACH Reporting Obligations — 31 May 2026

Separate from the D4/D5/D6 substance restriction, manufacturers face a distinct REACH compliance deadline on May 31, 2026. Under the REACH Regulation's requirements for synthetic polymer microparticles, manufacturers and importers must report emissions of synthetic polymers — including silicone-based particles — to ECHA by that date. This reporting obligation captures silicone microparticles generated during product use in rinse-off and leave-on applications, construction application, and industrial processes.

For companies that have not audited their formulations against the synthetic microparticles definition, the May 31, 2026 deadline represents a data collection challenge that cannot be deferred: it requires lifecycle emission mapping, particle size characterisation, and concentration quantification across all in-scope products. Companies that fail to report face direct regulatory sanctions and market access consequences in the EU single market.

#### Two Deadlines, One Month Apart

May 31, 2026: REACH synthetic polymer microparticles reporting deadline. June 6, 2026: D4/D5/D6 restriction effective for general consumer and professional use. Both require active compliance action — not monitoring. Both carry market access consequences for non-compliance. A company that is not already in remediation is behind schedule on both.

### 4.3 Penalty Three: Market Access Loss

From June 2026, products containing D4, D5 or D6 at concentrations equal to or greater than 0.1% by weight cannot be placed on the EU market in general consumer or professional use applications. This is not a soft compliance requirement with a grace period — it is a hard prohibition under REACH Annex XVII, enforceable by national competent authorities across all 27 EU member states.

The 2022 ECHA enforcement pilot — which found 3% of tested cosmetics non-compliant under the existing, narrower restrictions — resulted in market withdrawals. The 2026 restriction covers a wider substance scope (adding D6) and a wider application scope (leaving previously unrestricted leave-on cosmetics and general professional products). Enforcement infrastructure is proven. The question for any company with products in scope is not 'will enforcement occur?' — it is 'what is the cost of a market withdrawal?'

Risk Category	Impact Level	Cost / Consequence Detail
Product recall / market withdrawal	High	Per-product withdrawal costs: logistics, destruction, replacement stock. For a product range with €5M EU revenue, total withdrawal cost estimated €800K–€1.5M.
Reformulation under time pressure	High	Emergency reformulation (reactive vs. planned): R&D cost 2–4x higher than proactive equivalent. Compressed validation timelines increase failure rate.
Retailer delisting / de-ranging	Medium–High	EU food/drugstore retailers with ESG commitments are proactively screening supplier compliance ahead of deadline. Non-compliant products face de-ranging before the legal cutoff.
Reputational exposure	Medium	Enforcement actions are publicly registered with ECHA. NGO monitoring of non-compliant brands is active in personal care. B2B customers increasingly require REACH compliance certificates.
Export restriction	Medium	Non-compliant EU-formulated products that are also exported to jurisdictions with aligned restrictions (UK REACH under review; broader global harmonisation trajectory) face cascade market loss.

### 4.4 Penalty Four: Long-Term Environmental Liability

Silicone degradation timelines vary by polymer type and environmental conditions, but estimates for certain silicone formulations range from 50 to 500 years before complete breakdown — making them functionally persistent under any commercially relevant planning horizon. D4, D5 and D6, specifically, have been detected in Arctic ecosystems and demonstrate long-range atmospheric transport, confirming that emissions from product use do not remain local.

EU regulatory direction on persistent, bioaccumulative substances has a clear one-way trajectory: each review cycle has produced broader restrictions, not narrower ones. The 2018 Candidate List inclusion, the 2020 rinse-off restriction, the 2022 D4 cosmetics ban, and the 2024 comprehensive restriction are steps in a progression. Brands and manufacturers who are still supplying D4/D5/D6-containing products into the EU market after June 2026 are not managing a stable regulatory position — they are positioned against the direction of travel of the entire regulatory framework.

#### Elkem September 2025 — The Technology Signal

In September 2025, Elkem introduced a new range of solvent-free silicones produced entirely from recycled material, achieving a 70% reduction in carbon footprint versus conventional silicone production at equivalent performance. This is not a niche development — it is a signal that the supplier base is investing in sustainable silicone pathways. Companies reformulating now have access to lower-carbon silicone options that did not exist at scale two years ago, in addition to the established non-silicone alternatives mapped in Section 6.

## 5 The Cost Stack — What Delayed Reformulation Actually Costs

The financial case for reformulation is most clearly understood as a comparison of two cost stacks: the cost of proactive reformulation now versus the aggregate cost of reactive reformulation after a compliance event. The latter is not simply the former delayed — it carries additional costs from time pressure, enforcement exposure, and opportunity loss that compound with each quarter of deferral.

Proactive Reformulation — Initiated Q4 2025 or earlier	Reactive Reformulation — Post-enforcement / post-withdrawal
<ul style="list-style-type: none"> <li>• R&amp;D; and formulation development: planned timeline, normal iteration cycle</li> <li>• Safety assessment and validation: standard timeline (4–12 months personal care; 6–18 months industrial)</li> <li>• Supply chain transition: negotiated contracts, supplier qualification in parallel with existing production</li> <li>• Regulatory filing update: managed, no emergency premium</li> <li>• No production downtime: transition phased against inventory</li> <li>• Marketing opportunity: 'reformulated ahead of EU mandate' as verifiable competitive signal</li> </ul> <p><b>Estimated cost premium vs. no-change: +8–15% product COGS</b></p>	<ul style="list-style-type: none"> <li>• R&amp;D; under emergency conditions: 2–4× standard cost, compressed timelines, higher failure rate</li> <li>• Market withdrawal: logistics, destruction, lost revenue (€800K–€1.5M on €5M EU revenue line)</li> <li>• Regulatory enforcement response: legal cost, ECHA interaction, national authority engagement</li> <li>• Retailer delisting: revenue gap, shelf space loss, re-ranging cost at restart</li> <li>• Reputational exposure: enforcement actions publicly registered with ECHA; NGO monitoring active</li> <li>• Supply premium: purchasing into tightening compliant-material market without negotiated contracts</li> </ul> <p><b>Estimated cost premium vs. no-change: +25–60% product COGS</b></p>

COGS impact estimates are indicative ranges based on reformulation complexity, product category, and supplier base depth. Actual costs vary significantly by formulation and organisation.

## 6 The Alternatives Landscape — Performance and Pricing

The commercial availability of silicone alternatives has matured significantly since the initial D5 restriction in 2020. The global thermoplastic elastomers (TPE) market reached \$29.71B in 2024 and is projected to reach \$46.93B by 2033 (Market Data Forecast, CAGR 5.21%). Automotive applications account for 39.88% of TPE end-use. Several alternatives — MS polymers, EPDM, polyurethane systems — are technically proven across the principal silicone application sectors. The question is no longer whether alternatives exist. It is whether the reformulation programme has been initiated.

Alternative Material	Primary Applications	Performance Validation	Price Range	Supply & Market Context
Thermoplastic Elastomers (TPE)	Automotive seals, gaskets, hoses; industrial flexible parts; medical devices	High — automotive OEM qualification established (Teknor Apex Sarlink for EV battery seals, Dow ENLIGHT TPV)	~\$2.50–5.00/kg	Stable, multiple suppliers; 5.21% CAGR growth 2024–2033; 93% lower particulate shedding vs silicone in sterile environments (Fraunhofer Institute)
Thermoplastic Vulcanizates (TPV)	Under-hood automotive; HVAC seals; cable jacketing; EV battery components	Very high — under-hood temperature tolerance (140°C peaks); UL 2596 validated for EV battery gaskets	~\$3.00–6.00/kg	Fastest-growing TPE sub-segment; TPO/TPV leads 7.39% CAGR through 2030 (Mordor Intelligence)
MS Polymers / Hybrid Sealants	Construction sealants, glazing, roofing; industrial bonding; façade sealing	High — comparable weathering and adhesion to silicone sealants; OSI Quad, DAP Ultra Clear proven	~\$3.00–7.00/kg	Flat to +3% price trajectory; no D4/D5/D6 content; no REACH compliance risk
Polyurethane (PU) Systems	Coatings, adhesives, sealants, foams; personal care (emollients)	High in construction/industrial; moderate in personal care (different sensory profile)	~\$2.00–5.00/kg	Large established market; Covestro Cardyon TPU grades: 20% captured CO2 content, certified TÜV Rheinland
EPDM Rubber	Automotive gaskets and seals; weathering strips; roofing membranes	Proven — lower cost vs. silicone; good weather and UV resistance; preferred for automotive sealing	~\$1.80–3.50/kg	Commodity pricing; stable supply; widely used to replace silicone in automotive OEM applications
Hydrocarbon-based emollients (personal care)	Skin care, hair care, cosmetics; replacing D5 sensory function	Good — Sonneborn alkanes and petrolatums cited as immediate implementation solutions	~\$1.50–4.00/kg	Immediate availability; extensive supplier base; already in-market formulations
Elkem recycled solvent-free silicones (Sep 2025)	Industrial applications, coatings, electronics; where silicone required	Same performance as conventional; 70% lower carbon footprint; compliant formulation possible	Premium, not disclosed	For applications where silicone properties are irreplaceable; compliant if D4/D5/D6 <0.1% w/w

Sources: Mordor Intelligence TPE Market 2026; Market Data Forecast (2025); Fraunhofer Institute for Structural Durability; Covestro Cardyon press release March 2024; Elkem press release September 2025; Sonneborn industry Q&A; (2024). Silicone still "wins" (e.g., extreme high-temp flexibility), Trade-offs (e.g., TPVs having a different sensory "feel" in cosmetics).

## 7 ROI Analysis — The Reformulation Business Case

The reformulation ROI calculation must account for both direct cost savings (lower material input costs, avoided compliance costs) and indirect value creation (market access preservation, brand differentiation, supply chain stability). The case is strongest in sectors where the alternatives are technically proven and where the regulatory penalty for non-compliance is commercially material.

### 7.1 Sector-Specific ROI Assessment

Sector	Urgency Rating	Regulatory Exposure	Reformulation ROI Drivers
Personal Care & Cosmetics	Very High	<ul style="list-style-type: none"> <li>• D4 already prohibited in cosmetics since 2022</li> <li>• D5/D6 <math>\geq 0.1\%</math> banned from June 6, 2026 (general), June 6, 2027 (leave-on)</li> <li>• ECHA 2022 pilot: 3% non-compliance → market withdrawals</li> <li>• Immediate alternatives: Sonneborn alkanes, PU emollients, compliant silicone sub-threshold grades</li> </ul>	<ul style="list-style-type: none"> <li>• Cost stability: hydrocarbon alternatives ~30% cheaper than D5 grades</li> <li>• Competitive signal: 'D5/D6-free' positioning increasingly demanded by EU retailers and brand owners</li> <li>• ROI payback: 12–24 months on R&amp;D; investment through materials cost reduction and avoided recall risk</li> </ul>
Construction Sealants & Industrial	High	<ul style="list-style-type: none"> <li>• General consumer/professional restriction: 6 June 2026</li> <li>• Silicone sealants in consumer DIY applications in scope</li> <li>• Professional application sealants: in scope from June 2026</li> <li>• Alternative: MS polymers and hybrid sealants proven at scale</li> </ul>	<ul style="list-style-type: none"> <li>• MS polymers: equivalent or superior weathering and adhesion</li> <li>• Price stability: flat to +3% vs. silicone at +10%+</li> <li>• Supply: large multi-source market, no single-supplier dependency</li> <li>• ROI payback: 18–36 months on formulation investment</li> </ul>
Automotive	Medium–High	<ul style="list-style-type: none"> <li>• Under-hood silicone components: indirect exposure</li> <li>• Silicone-based coatings and polishes: June 2026 restriction</li> <li>• TPE/TPV already specified by OEMs for EV battery applications</li> <li>• OEM sustainability requirements accelerating transition</li> </ul>	<ul style="list-style-type: none"> <li>• TPE/TPV: under-hood temperature performance validated</li> <li>• Celanese Hytrel TPC-LCF: 50% carbon footprint reduction, Inflation Reduction Act incentive-aligned</li> <li>• EV specification shift from silicone to TPV already in progress</li> <li>• ROI payback: 24–48 months; primarily driven by OEM pull</li> </ul>
Coatings & Paints	Medium	<ul style="list-style-type: none"> <li>• Silicone additives in coatings: general professional use restriction from June 2026</li> <li>• Defoamers, levelling agents, slip additives under review</li> <li>• Non-silicone defoamer market growing independently of D4/D5/D6</li> </ul>	<ul style="list-style-type: none"> <li>• Non-silicone emulsion defoamer market: stable supply, growing through 2035 (briefing data)</li> <li>• Regulatory signal: proactive reformulation avoids cascade risk if defoamer-containing products trigger review</li> <li>• ROI payback: 24–48 months; lower urgency than personal care</li> </ul>

### 7.2 Cost Stability as an ROI Driver

Beyond compliance avoidance, the reformulation ROI case rests partly on input cost trajectory. Compliant silicone alternatives — particularly TPE, TPV, MS polymers, and polyurethane systems — are priced into a large, multi-supplier, growing market. The non-silicone emulsion defoamer market, for example, is expected to expand through 2035, offering improved supply chain predictability relative to a silicone specialty additive market facing simultaneous demand pressure from compliant reformulations and supply restructuring as D4/D5/D6 grades are withdrawn.

Companies that complete reformulation now lock in supplier relationships, validated specifications, and contract pricing before the post-June 2026 scramble for compliant alternatives compresses availability and pushes spot prices. The procurement advantage of early movers is a concrete, quantifiable component of reformulation ROI.

## 7.3 Case Study: The Financial Anatomy of Reactive Reformulation

This breakdown illustrates the specific financial penalties of reactive reformulation — the high cost of moving fast when the regulatory clock has run out. Reactive costs are typically 200% to 500% higher than planned R&D; because they force a transition from 'efficiency-driven' operations to 'survival-driven' operations.

### 1. Third-Party Lab Testing: The 'Rush Fee' Escalator

In a standard compliance cycle, testing for substances like D4/D5/D6 is batched to save costs. In an emergency (e.g., June 1, 2026, with a June 6 deadline), labs leverage their limited bandwidth through surcharges.

Service Level	Turnaround Time	Surcharge Rate	Est. Cost (per Sample)
Standard	10–15 Business Days	0% (Baseline)	\$500 – \$1,200
Priority	5 Business Days	+50% to 100%	\$1,000 – \$2,400
Emergency	48 Hours	+150% to 200%	\$1,500 – \$3,600
Same-Day	< 24 Hours	+300% or 'Flat Fee'	\$2,500+

#### The 'Hidden' Lab Costs

- **Sample Prep Surcharges:** For complex matrices (e.g., waterproof coatings or thick sealants), labs charge extra for the specialised extraction required on short notice.
- **Courier/Logistics:** Shipping hazardous chemical samples via 'Next Flight Out' services can cost \$500–\$1,000 per shipment, compared to standard \$50 ground shipping.

### 2. Manufacturing: The Cost of 'Slot-Jumping'

'Slot-jumping' occurs when a company halts an existing, profitable production run to squeeze in a newly reformulated, compliant batch. This disrupts the Overall Equipment Effectiveness (OEE) and incurs heavy penalties.

#### Hypothetical Breakdown: 24-Hour Production Halt

Scenario: A facility produces 5,000 units/day of a legacy industrial sealant. To avoid a June 6 market ban, they 'jump' a new formulation into the schedule.

**Opportunity Cost (Lost Revenue):** Halting a high-margin line for 24 hours to re-tool and flush the system. **Est. Loss: \$50,000 – \$250,000 (depending on product value).**

**System Flush/Purge Waste:** Switching from a D5-based silicone to an MS Polymer requires an aggressive chemical purge to prevent cross-contamination. **Waste Cost: 500kg of 'scrap' material + specialised cleaning agents (\$5,000 – \$15,000).**

**Labor Overtime:** Emergency re-tooling often requires maintenance and engineering teams to work 1.5x or 2x shifts to recalibrate machinery for different viscosities. **Est. Cost: \$8,000 – \$12,000.**

**Expedited Ingredient Sourcing:** To get the new raw materials (TPE/MS Polymers) to the plant in 48 hours, you pay a 'Spot Market' premium. **Est. Premium: 20% to 50% above contract pricing.**

### 3. Case Study: The 'Reactive' vs. 'Proactive' ROI

The following table compares a mid-sized sealant manufacturer's costs for a 10-product portfolio.

Expense Category	Proactive (Q3 2025)	Reactive (May 2026)	The 'Penalty'
Lab Testing	\$12,000 (Standard)	\$36,000 (Rush)	+\$24,000
R&D; Labor	\$40,000 (Internal)	\$120,000 (Consultants)	+\$80,000
Supply Chain	Contract Pricing	+30% Spot Premium	+\$45,000
Production	Scheduled Changeover	Slot-Jumping Penalty	+\$150,000

**The 'Fatal' Cost:** Beyond the \$300k+ delta, the reactive company risks Retailer Delisting. If the compliant batch fails its rush-test, the 'slot' is wasted, the deadline is missed, and the shelf space is permanently lost to a competitor who moved in 2025.

## 8 Strategic Recommendations

The recommendations below are ordered by urgency. They apply to any manufacturer, formulator or brand owner with products in scope for the June 2026 or June 2027 restrictions.

Prio rity	Timeline	Action	Rationale / Detail
01	Immediate (Now–Q1 2026)	Product formulation audit	Map all in-scope products against the D4/D5/D6 restriction definitions. Identify which products contain these substances at $\geq 0.1\%$ w/w. Segment by restriction deadline (June 2026 vs. June 2027 vs. 2031). This audit is the prerequisite for every subsequent action — it cannot be done reactively after a compliance event.
02	Immediate (Now–Q1 2026)	REACH microparticles reporting preparation	May 31, 2026 reporting deadline for synthetic polymer microparticles. Initiate lifecycle emission mapping for silicone-containing products now. This requires particle size characterisation and emission quantification across the in-scope product portfolio — a multi-week minimum undertaking.
03	Urgent (Q1–Q2 2026)	Reformulation programme initiation	For products with June 2026 deadline: reformulation should already be in validation or final approval. Emergency reformulation timeline minimum 3–6 months. For products with June 2027 deadline: initiate now to avoid reactive timeline compression.
04	Q1–Q2 2026	Alternative supplier qualification	Qualify two or more alternative material suppliers for each D4/D5/D6-replacing ingredient. Single-source dependency on a compliant alternative replicates the supply chain vulnerability of the existing silicone dependency.
05	Q2 2026 onward	Competitive positioning communication	Brand owners who complete reformulation ahead of the June 2026 deadline have a concrete, verifiable environmental claim available: 'reformulated to remove D4/D5/D6 ahead of EU mandate.' This is a factual, compliance-grounded claim that differentiates from competitors who have not yet completed transition. B2B customers increasingly require supplier compliance certificates.
06	Ongoing	Regulatory monitoring post-2026	The 2026 restriction is not the end of the regulatory trajectory. ECHA's proposal for D4/D5/D6 inclusion in the Stockholm Convention on Persistent Organic Pollutants would trigger global restrictions. UK REACH is under active review. Monitor the ECHA Authorisation List proposal (under evaluation). Build a regulatory monitoring function for cVMS and adjacent substances.

### The Competitive Window Is Closing

Early movers on reformulation gain access to supplier contracts and validated specifications before the June 2026 market tightening. They can communicate a genuine compliance credential to EU retail buyers who are already proactively screening supplier reformulation status. They avoid the 2–4x cost premium of emergency reformulation. And they position against the only trajectory that EU regulatory policy on persistent organic pollutants has shown over two decades: restrictions widen, they do not narrow. The question is not whether to reformulate. It is whether to reformulate now at planned cost or later at emergency cost.

## 9 Forward View — What Happens After June 2026

The June 2026 restriction date is the most visible inflection, but it is not the final one. The regulatory and market trajectory for cyclic siloxanes extends well beyond 2026 on multiple dimensions.

Timeline	Event / Requirement	Status
June 6, 2026	D4/D5/D6 $\geq 0.1\%$ w/w banned in all general consumer and professional products (EU market)	In force
May 31, 2026	REACH synthetic polymer microparticles reporting deadline for manufacturers and importers	In force
June 6, 2027	D5/D6 restriction extends to leave-on cosmetic products (make-up, face creams, hair styling)	Confirmed
2027–2028 (projected)	CBAM scope expansion to organic chemicals and polymers. Silicone imports from high-carbon-intensity producers may face carbon adjustment cost	Expected, not yet in force
June 6, 2031	Medical devices and medicinal/veterinary products: D4/D5/D6 restriction becomes applicable	Confirmed
June 6, 2034	Dry cleaning: D5 as solvent in open systems restricted. Closed-loop recycling systems derogated.	Confirmed
Post-2026 (date TBD)	ECHA proposal for D4/D5/D6 under Stockholm Convention on Persistent Organic Pollutants (global restrictions) — Commission closed its nomination but ECHA dossier active	Under evaluation
UK REACH — under review	HSE call for data on cyclosiloxanes launched March 2023. UK restrictions may diverge or align with EU — monitoring required	Under review

### The Intersection with CBAM

Commission Regulation (EU) 2024/1328 restricts D4/D5/D6 in products. Separately, the EU Carbon Border Adjustment Mechanism (CBAM) entered its definitive phase on January 1, 2026. Silicone and organic chemicals are not currently within CBAM scope (which covers cement, steel, aluminium, fertilisers, electricity and hydrogen). However, the European Commission is studying CBAM expansion to organic chemicals and polymers, with inclusion expected no earlier than 2027–2028. If silicones are included, Chinese-produced silicone — manufactured with coal-intensive energy — would carry a CBAM certificate cost against EU-produced equivalents. This would further shift the economics in favour of European silicone alternatives and compliant domestic production. The Elkem recycled solvent-free silicone (September 2025) with 70% lower carbon footprint is positioned to benefit from any such expansion. If organic chemicals might be included by 2027-2028, it could more explicitly highlight that TPEs/TPVs produced within the EU might eventually hold a significant tax advantage over imported Chinese silicones, further boosting the ROI of domestic substitution. The Elkem Pathway could act as a "middle path" for industries where TPE/TPV properties are insufficient, because "substitution" doesn't always mean "abandoning the chemistry," but rather "evolving the source."

## Sources and References

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1. Commission Regulation (EU) 2024/1328 of May 16, 2024 amending Annex XVII to Regulation (EC) No 1907/2006 (REACH) regarding D4, D5 and D6. Official Journal of the European Union, L, 2024/1328.
2. ECHA (2025). Cyclosiloxanes — Hot Topics Page. European Chemicals Agency. [echa.europa.eu/hot-topics/cyclosiloxanes](https://echa.europa.eu/hot-topics/cyclosiloxanes).
3. ECHA Enforcement Forum (2022). Pilot project — cosmetics compliance with cyclosiloxane restrictions. 3% non-compliance rate documented; market withdrawals enacted.
4. H2 Compliance (March 2025). EU Adopted Restriction of Siloxanes — deadline and derogation summary. [h2compliance.com](https://h2compliance.com).
5. Intertek (May 2024). EU REACH — Commission Adopts EU-wide Restriction on Cyclosiloxanes (D4, D5, D6). [intertek.com insight bulletin](https://intertek.com/insight/bulletin).
6. CIRS Group (March 2025). In-Depth Analysis: EU Regulatory Measures on Cyclosiloxanes. [cirs-group.com](https://cirs-group.com).
7. Shin-Etsu Chemical (June 2024). Global price revision of 10% or more for all silicone products, effective July 1, 2024, citing raw material and energy cost increases. Press release.
8. Grand View Research (2025). Silicone Market Size, Share & Growth | Industry Report, 2033. \$24.26B in 2025, CAGR 5.4%.
9. Polaris Market Research (2025). Silicone Market Size and Forecast. \$22.67B in 2024, CAGR 6.15%. Asia-Pacific 45.79% share in 2025.
10. Maximise Market Research (2025). Silicone Market — \$22.88B in 2024, CAGR 6.1% to 2032.
11. Market Data Forecast (October 2025). Thermoplastic Elastomers Market. \$29.71B in 2024, CAGR 5.21% to \$46.93B by 2033. Automotive 39.88% of end-use in 2024.
12. Mordor Intelligence (January 2026). Thermoplastic Elastomers (TPE) Market. \$34.30B in 2025, projected \$44.10B by 2030.
13. Fraunhofer Institute for Structural Durability. TPE-integrated medical seals: 93% lower particulate shedding in sterile environments vs. silicone. Cited in Market Data Forecast TPE report (2025).
14. Elkem (September 2025). New solvent-free silicones produced from recycled material, 70% reduced carbon footprint at equivalent performance. Company press release.
15. Covestro (March 2024). Cardyon® TPU grades commercialised with 20% captured CO2 content, TÜV Rheinland certified. Press release.
16. Dow (February 2024). ENLIGHT™ TPV for EV battery gaskets — electrolyte resistance and thermal expansion matching; UL 2596 validated. Press release.
17. Sonneborn / HF Sinclair (2024). Industry Q&A: Understanding the Impact of the EU Silicone Ban and Sonneborn's Alternatives. [sonneborn.com](https://sonneborn.com).
18. Allied Market Research (2024–2025). Silicone Market — elastomers segment dominant; EPDM, nitrile rubber, MS polymers cited as silicone substitutes in automotive and construction applications.
19. EU CBAM (2026). Carbon Border Adjustment Mechanism — definitive phase from 1 January 2026. Current scope: cement, steel, aluminium, fertilisers, electricity, hydrogen. Organic chemicals expansion: 2027–2028 projected.
20. UK HSE (March 2023). Call for data on cyclosiloxanes under UK REACH — assessment of whether further restrictions are necessary. Under review.